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1997-98 School Year

Chemistry 30 Information Bulletin

Diploma Examinations Program

Students
First!
Student Evaluation

Alberta
EDUCATION

This document was written primarily for:

Students	✓
Teachers	✓ Chemistry 30 teachers
Administrators	✓
Parents	
General Audience	
Others	

Distribution: Superintendents of Schools • School Principals and Teachers • The Alberta Teachers' Association • Alberta Education • General Public upon Request

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***Alberta educators** may reproduce this bulletin for **educational purposes**.*

This document can be found on our Web pages. Our Internet address is http://ednet.edc.gov.ab.ca.

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Purpose of the Bulletin

The purpose of this bulletin is to provide students and teachers of Chemistry 30 with information about the diploma examinations scheduled for the 1997–98 school year.

This bulletin includes descriptions of the Chemistry 30 diploma examinations, that will be administered in November 1997, January, June, and August of 1998, descriptions of the acceptable standard and the standard of excellence, and subject specific information.

Teachers are encouraged to share the contents of this bulletin with students.

As well, the publication *Students First: A Guide for Students Preparing to Write the Chemistry 30 Diploma Examination* contains significant information for students.

The document entitled *General Information Bulletin, Diploma Examinations Program* (1997–98) provides administrative information about the diploma examinations for the 1997–98 school year.

This bulletin, the *General Information Bulletin*, and the *Students First* guide are distributed to all senior high school principals and are also available on the Internet at Alberta Education's Web site (http://ednet.edc.gov.ab.ca).

If you have questions or comments about the contents of this bulletin, please contact one of the following persons:

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Important Dates in 1997–98 School Year

Administration of the Chemistry 30 Diploma Examination

The diploma examination is designed for a writing time of 2.5 h. Students must be allowed an additional 0.5 h to complete the examination, if required; therefore, examination supervisors must be available for this additional time.

1997–98 Administrations	*Time*
Wednesday, November 5, 1997	1:00–3:30 P.M.
Monday, January 26, 1998	1:00–3:30 P.M.
Tuesday, June 23, 1998	1:00–3:30 P.M.
Tuesday, August 11, 1998	1:00–3:30 P.M.

Please consult the *General Information Bulletin, Diploma Examinations Program*, for a complete schedule for all subject areas.

Scoring of the Examination

Scoring of the examination will take place shortly after the administration date.

In early September, the Student Evaluation Branch sends superintendents a letter requesting the names of recommended markers. In this letter, dates for scoring the examination will be announced.

Student Evaluation Branch staff will contact recommended markers before each marking session to confirm participation, and the dates and times for marking.

Notes of Interest

Additional Diploma Examination Administrations

Alberta Education is increasing the number of administrations of diploma examinations to accommodate students' examination needs more effectively. For the 1997–98 school year, in addition to the examinations already offered in January, June, and August, the following diploma examinations will be offered in November and April.

Tuesday, November 4, 1997	9:00–11:30 A.M.	English 30 Part A English 33 Part A
Wednesday, November 5, 1997	9:00–11:00 A.M.	English 30 Part B English 33 Part B
	1:00–3:30 P.M.	Chemistry 30
Thursday, November 6, 1997	9:00–11:30 A.M.	Mathematics 30 Mathematics 33
Monday, April 20, 1998	9:00–11:30 A.M.	Social Studies 30 Social Studies 33
	1:00–3:30 P.M.	Physics 30
Tuesday, April 21, 1998	9:00–11:30 A.M.	Biology 30

The November and April examinations will be available only to students who have school marks in the courses and to individuals having mature student status.

All students must preregister to write diploma examinations in November and April; walk-ins will not be allowed. Students should contact their school principal for application forms and for the location of the nearest writing centre. The application deadlines for the November and April writings are October 10, 1997, and March 26, 1998, respectively.

Data Resources for Students

The Chemistry 30 diploma examinations require the use of a separate data booklet. There are no changes to the data booklet (Copyright 1995) for the 1997–98 school year.

Student Use of Scientific Calculators

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students. Students are expected to provide their own scientific calculators.

Refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing examinations. It is important to clarify with students exactly what they are allowed to have stored in their calculator memories.

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations (see the *General Information Bulletin*).

Student Requests for Rescores

Students may request a rescoring of their diploma examinations. Before applying for a rescoring, students should check their *Diploma Examination Results Statement* to find out the distribution of marks. The mark on the machine-scored questions is not likely to change as a result of a rescore, but the written-response mark could change slightly. Students should remember that the rescored mark will be the final mark whether it *increases* or *decreases*.

Students who decide to have an examination rescored must ensure that their application is received before the deadline specified on the results statement. The fee for rescoring each examination is $26.75, which includes GST. If a diploma examination mark is increased by 5% or more as a result of rescoring, the fee is refunded.

Student Requests for Rewriting

Students may rewrite a diploma examination in any regularly scheduled administration. The fee for rewriting each examination is $26.75, which includes GST. Please note that this rewrite fee applies to students repeating the course as well as to those who choose to write the examination. Students must apply to the Student Evaluation Branch by the following dates to be eligible to rewrite the diploma examinations.

Examination Administration	**Rewrite Request Deadline**
November 1997	October 10, 1997
January 1998	November 14, 1997
June 1998	April 29, 1998

(For more details, see the *General Information Bulletin*.)

Children in Need of Protective Services

If a student who is under 18 years of age indicates in his or her writing that he or she is a victim of physical or sexual abuse, the markers are required *by law* to refer the paper to Social Services. Social Services is required to investigate situations that suggest that children might require protection.

Information for Markers

The written-response questions of the Chemistry 30 Diploma Examinations are marked by Chemistry 30 teachers selected from those who have been recommended as markers to the Student Evaluation Branch by their superintendents.

Qualifications

To qualify for recommendation, a teacher must have taught the complete Chemistry 30 course for two or more years (or four semesters) prior to the current school year, be teaching the course in the current school year, and have an Alberta or Northwest Territories Permanent Professional Teaching Certificate.

Dates for Recommendation

Teachers who wish to be recommended as markers for the diploma examinations should contact their superintendents by the following dates.

Diploma Date	**Contact Superintendent by**
January 1998	October 01, 1997
June & August 1998	March 01, 1998

Markers for the November and April examinations will be selected from lists of prospective markers submitted by their respective school superintendents.

Criteria for Selection

More teachers are recommended as markers by superintendents than are required by the Student Evaluation Branch for any one marking session. The following criteria are considered when markers are selected for a particular marking session:

- experience as a marker (experienced markers and first-time markers are included)
- regional representation (by zone, jurisdiction, and school)
- student population (proportional representation)

We particularly need teachers who can mark examinations written in French.

Examination Development

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. Item writing takes place throughout the year and is a vital component of the diploma exam program. Field testing provides students and teachers with the opportunity to become familiar with the nature of questions they will encounter on future diploma exams. Only teachers who have been nominated by their superintendents are eligible to participate in these activities. Therefore, it is essential that teachers who are interested in these activities should contact their superintendents.

Inservices and Presentations

On a limited basis and subject to budget constraints, Student Evaluation Branch staff may be available to provide inservices or presentations related to diploma examinations or the interpretation of diploma examination results.

Other Important Documents

Guide for Students

A publication written for students called *Students First: A Guide for Students Preparing to Write the Chemistry 30 Diploma Examination* is available in each senior high school and on Alberta Education's Web site (http://ednet.edc.gov.ab.ca). This publication contains suggestions for exam preparation and exam writing suggestions. The Student Evaluation Branch highly recommends that students and teachers examine this document early in the term to prepare for the Chemistry 30 Examination. Parents will also find this to be a useful publication.

Examiners' Reports

Following the administration of each January and June diploma examination, the Student Evaluation Branch sends copies of the *Chemistry 30 Examiners' Report* to all senior high schools in Alberta, and also posts it on Alberta Education's Web site (http://ednet.edc.gov.ab.ca).

The *Examiners' Report* contains

- detailed provincial results
- examiners' comments about student performance on the exam
- a detailed blueprint of the examination by reporting category
- the key and difficulty level for all the questions on the examination
- sample questions accompanied by commentary

The *Examiners' Report* provides important information for teachers who wish to interpret their students' results in relationship to provincial results as an ongoing form of program evaluation.

School and Jurisdiction Reports

School and Jurisdiction Statistical Reports are made available to schools and school jurisdictions after each January and June administration of the diploma examinations. These reports are placed on the Dial-In Facility of the Educational Information Exchange and provide detailed information on how well the students in their school and school district, respectively, did on each of the diploma examinations. Teachers may use these data to reflect on the areas of the program where their students did well and those areas where student performance was poor.

Annual Reports

Each year, the Student Evaluation Branch produces the *Annual Report, Diploma Examinations Program*. This report contains information about the results achieved by all students who wrote diploma examinations in the preceding school year. It also contains special studies on topics of interest.

Each of these special studies will be of interest to teachers who are involved in interpreting the diploma examinations results of their students.

Diploma Examinations Program

Year	Special Studies Topic
1989–90	Comparing Achievement in Various Diploma Examination Courses
1990–91	Different Paths to Success in Diploma Examination Courses
1991–92	Participation Rates in Diploma Examinations Courses
1992–93	Conventions of Language
1993–94	Participation Rates Over Time
1994–95	Grade 12 Enrollment Decline—A Preliminary Assessment
1995–96	Differential Item Performance Between Males and Females on the June 1996 Administration of the Social Studies 30 Diploma Examination

The 1995–96 Annual Report is available on the Internet at Alberta Education's Web site (http://ednet.edc.gov.ab.ca).

General Information Bulletin

Each September, the Student Evaluation Branch sends all senior high school principals and superintendents copies of the *General Information Bulletin, Diploma Examinations Program*, and also posts it on Alberta Education's Web site (http://ednet.edc.gov.ab.ca). This bulletin provides the information, dates, policies, and rules that apply to the administration of all diploma examinations for the school year.

Teachers and students who have questions about such issues as partial writings, word-processor policy details, special provisions for learning and/or physically disabled students writing diploma exams, dates for exam administration, and definitions of mature students, should consult this bulletin.

Previous Examinations

Previous Chemistry 30 January and June diploma examinations are posted on the Alberta Education's Web site (http://ednet.edc.gov.ab.ca) and are also available for purchase (@$4.00 + G.S.T.) from the

Learning Resources Distributing Centre
12360-142 Street, Edmonton, AB T5L 4X9
Phone: 403-427-5775 (toll-free 310-0000) Fax: 403-422-9750

Teachers and students who are consulting previous exams should use exams administered under the present *Program of Studies*.

Chemistry 30 Information

Objectives of the Course

Chemistry 30 is intended for students who want to better understand the chemistry principles behind the natural events they experience and the technology they use in their daily lives. Chemistry 30 is an experimental discipline requiring creativity and imagination. The course is designed for students who are preparing for academic post-secondary studies.

Students of Chemistry 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of chemical concepts, ability to apply these concepts to relevant situations, and ability to communicate in the specialized language of chemistry.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, and in particular by the successful completion of Science 10 and Chemistry 20. These courses develop knowledge and skills that are prerequiste to success in Chemistry 30.

Standards

Students who achieve an *acceptable* standard of performance in Chemistry 30 receive a final mark of 50% or higher. These students can demonstrate a basic understanding of the nature of scientific investigation by designing, observing, and interpreting simple laboratory tests. They can readily interpret data that are presented in simple graphs and tables, and can translate symbolic representations into word descriptions. They can readily recognize and provide definitions for key chemical terms. They can predict the physical and chemical properties of compounds. These students can demonstrate an acceptable level of understanding of chemical concepts by performing routine stoichiometric problems that involve single steps. They are capable of balancing an equation (combustion, formation, neutralization, or redox) and solving standard stoichiometric problems based upon these equations. Following the directions in laboratory procedures does not present a problem for these students, nor does using the data booklet to extract valid information. These students can compose clear and logical descriptive or explanatory statements to answer closed questions that involve an individual chemistry concept.

Students who achieve a standard of *excellence* in Chemistry 30 receive a final mark of 80% or higher. In addition to meeting the expectations for an acceptable standard of performance, these students demonstrate an interest in chemistry and can articulate chemistry concepts well. They can readily interpret interrelated sets of data such as complex graphs and tables. When presenting scientific data, they select the most appropriate form. These students can analyze and evaluate experimental designs. They can create their own laboratory procedures when given a clear definition of a problem. They can recognize weaknesses in laboratory work and can find ways to correct the weaknesses. They can write their own equations for formation, combustion, neutralization, and redox reactions, and can solve many variations of stoichiometric problems based upon these equations, including equilibrium expressions. They are able to transfer what they see happening in a test tube into equation form and are able to express scientific ideas clearly. They can usually cope with problems that involve overlapping of two or more concepts. The most significant characteristic of this group is that they can solve problems of a new and unique nature and can extrapolate these solutions to higher levels of understanding. Open-ended questions are not a problem for them. These students can communicate clearly and concisely, using appropriate scientific vocabulary.

Examination Specifications

Each Chemistry 30 diploma examination is designed to reflect the Chemistry 30 course general learner expectations outlined in the *Chemistry 20–30 Program of Studies, Interim 1995, for Senior High Schools*. Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the examination. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics; this is also true of the STS connections.

Knowledge **Emphasis**

100%

The student can:

- apply conservation of matter and energy to changing systems; use evidence and knowledge to predict outcomes in a broad range of reactions
(30%–40%)
- analyze and evaluate physical, chemical, and biological systems in terms of energy, matter forms, transfers, movement, and conservation
(60%–70%)
- explain the relationships in physical, chemical, and nuclear changes through the rearrangement of bonds and the resulting release or absorption of energy
(28%–32%)
- quantitatively and qualitatively explain and analyze the transfer of electrons and the associated transformations that take place in electrochemical systems
(30%–34%)
- quantitatively and qualitatively describe equilibrium systems for acids, bases, and gases and some of their applications
(16%–22%)
- quantitatively and qualitatively describe acids and bases in physical and conceptual terms (Brønsted–Lowry)
(16%–22%)

Skills **Emphasis**

40 to 60%

The student can:

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

Connections Among Science, Technology, and Society (STS) **Emphasis**

40 to 60%

The student can:

- apply cause-and-effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory; and explain the limitations of science and technology in answering questions and solving problems
- describe and evaluate the design and function of technological solutions to theoretical and practical problems; and relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society; assess the ability to interact responsibly with the environment
- apply the skills and knowledge acquired in science to everyday life

Some examination questions are organized into sets that relate to broad contexts. Therefore, a set of questions may assess students' ability to integrate several general learner expectations (GLEs). All questions will measure achievement of scientific knowledge; some will also measure achievement of skills and/or STS connections.

Note: Appendix D contains an *Alternative Blueprint Format.*

Examination Design

The design of the 1997–98 Chemistry 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple Choice	44	55
Numerical Response	12	15
Written Response	2	30

The machine-scored portion of each examination contains both multiple-choice and numerical-response questions, some of which may be linked together.

Multiple-choice questions are of two types: *discrete* and *context-dependent*. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. A context-dependent question provides information separate from the question stem. Most of the multiple-choice questions are *context-dependent.*

A particular context may be used for more than one multiple-choice question, one or more numerical-response questions, as well as for one written-response question. Context information appears in grey boxes. Questions may be on more than one page with the end of a context sequence designated by a grey bar or a new grey box.

Answers for multiple-choice questions are recorded in the first section of the machine-scored answer sheet, and answers for numerical-response questions are recorded in the second section on the same side of the same machine-scored answer sheet. Answers to the written-response questions are written directly in the exam booklet.

Numerical-response questions are of three types: calculation of numerical values, selection of numbered events or structures from a list, and determination of a sequence of events.

Some questions are linked in such a way that the correct answer to the second question is dependant upon the answer to the first question. The second of the linked questions will be scored based upon the correct manipulation of the previous answer; thus, it is possible to receive marks for a question even though the preceeding question was answered incorrectly. The first question could be either a multiple-choice question or a numerical-response question. In the case of a multiple-choice question, the student should use the selected value rather than any value that may have been determined. This means that the potentially unrounded value displayed on a calculator would not be used. In the case of a numerical-response question, the value used must be the same as the value recorded.

The number of linked items will not exceed four in any single series. The usual linking will be between either a multiple-choice or numerical-response item and a numerical-response item; however, multiple-choice or numerical-response items may be linked to multiple-choice item(s).

The written-response portion of each Chemistry 30 diploma examination contains two questions: an analytically scored question and a holistically scored question. Each question has a value of 15 percent of the examination (or 12 marks).

Emphases in the 1997–98 Examinations

NEW

- Students will be required to distinguish between fission and fusion reactions. They should be able to recognize the fusion reaction that takes place on the Sun. To avoid confusion between phase and nuclear changes, the terms nuclear fission and nuclear fusion will be used.
- Students are expected to balance nuclear equations for nuclear fission and nuclear fusion reactions.

NEW

- Students are expected to recognize the contribution translational, rotational, and vibrational motion make to energy changes; i.e., kinetic energy
- Students are expected to be able to perform calculations using the Ideal Gas Law.
- Students are expected to be able to determine the meaning of potentially unfamiliar words from the context in which they are used. For example, electrowinning, sacrificial anode, and cathodic protection are all terms that refer to electrolytic systems.
- Students are expected to be able to write balanced net ionic equations for chemical reactions.
- Students are expected to solve machine-scored questions that relate directly to the nature of STS connections.
- Students are not expected to be able to predict whether or not a reaction is quantative. However, this is not meant to discourage the teaching of this concept. Students should be able to recognize when a reaction is quantitative from information provided to them.
- Students are expected to be as familiar with calculations involving K_b as they are for those involving K_a.
- Students are expected to know that $K_a \times K_b = K_w$.
- Students are expected to be able to solve linked questions.

- We will continue to evaluate written-response questions on how well the answer is communicated.
- Some questions will include concepts from more than one of the units.
- Written-response questions will require students to see relationships among concepts learned and require students to supply appropriate contexts.
- Some questions will require students to apply what they have learned to new contexts.
- Written-response questions may require students to write balanced chemical equations including correct states of matter.
- Students are expected to devise a balanced half-reaction in acid or neutral solution. They will be expected to balance chemical equations that occur in basic environments, but not by devising their own half-reactions.
- Students are expected to balance an auto-oxidation (disproportionation) reaction given the reagents involved.

CLARIFICATION

- Numerical answers are to be rounded only once, at the end of the question. Intermediate numbers are to be used as displayed on the student's calculator. For linked questions, answers are to be rounded at the end of each question. Thus, the values used in the linked question should be the rounded value, since linked questions are **not one** question but a series of independent items.
- Students are expected to use the appropriate SI notations in their responses. A list of these symbols can be found in the new data booklet.
- Students will **not** be expected to solve questions utilizing $\Delta E_p = vc\Delta t$. This requires the use of density and implies that a volumetric measure, such as gas volumes, would be appropriate. The expansion of the curriculum through this interpretation is not appropriate or valid. This concept is also flawed, in that specific heat capacity is a measure based only on mass and hence "vc" has no meaning. Additionally, the use of volume is problematic in that volume is temperature dependent, like "c."
- The diploma examination treats the terms "oxidation number" and "oxidation state" as synonyms. Students are expected to assign oxidation numbers to hydrides and peroxides.
- The diploma examination will define "electrochemical cells" as either Voltaic cells or electrolytic cells. The term galvanic will not be used on the diploma examination.
- Students will **not** be expected to solve questions utilizing the quadratic equation. However, it is expected that the student set up

the relationship correctly and that only when the mathematical operation is to take place is a statement about approximation to be made and used. However, this is not meant to discourage the teaching of this concept. Furthermore, a student will be expected to use a quadratic equation to solve a question in the written-response section of the examination **if** the student answers an open-ended question by citing an acid or base that an approximation cannot be made for. No student will be penalized on any portion of the examination for using the quadratic equation to solve a problem.

- The use of approximation to solve equilibrium expressions is only acceptable when the solving of the question results in a quadratic expression and the original concentration of the acid or base is one thousand fold greater than the K_a or K_b.
- Students are expected to determine the pH at the equivalence-point of a reaction, and at different volumes after the equivalence-point has been reached.
- Students are expected to know that the term amphiprotic is a synonym for amphoteric, thus either term may be used on diploma examinations.

CLARIFICATION

- Students are expected to predict how a wide range of factors affect an equilibrium and/or the equilibrium constant.

Students are expected to write equilibrium expressions for homogeneous and heterogeneous equilibria. The diploma examination will employ the convention of including in equilibrium expressions only substances that can vary in concentration.

Gases must be included since the concentration of a gas can be altered by varying the pressure on it.

For example, $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$

$$K_{eq} = \frac{[H_{2(g)}][CO_{2(g)}]}{[CO_{(g)}][H_2O_{(g)}]}$$

Aqueous ions and/or gases in solution must be included since the concentration of aqueous ions and/or gases can be altered by varying the volume of solvent.

For example, $N_2H_{4(g)} + H_2O_{(l)} \rightleftharpoons N_2H_5{}^+{}_{(aq)} + OH^-{}_{(aq)}$

$$K_{eq} = K_b = \frac{[N_2H_5{}^+{}_{(aq)}][OH^-{}_{(aq)}]}{[N_2H_{4(g)}]}$$

Pure solids are not included since the concentration (density) cannot be varied.

For example, $2NaHCO_{3(s)} \rightleftharpoons Na_2CO_{3(s)} + H_2O_{(g)} + CO_{2(g)}$

$$K_{eq} = [CO_{2(g)}][H_2O_{(g)}]$$

Pure liquids are not included since the concentration (density) cannot be varied.

For example, $2H_{2(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(l)}$

$$K_{eq} = \frac{1}{[H_{2(g)}]^2[O_{2(g)}]}$$

Mixtures of liquids must be included since the concentration can be varied by changing the relative amounts of the mixed liquids.

For example, $C_6H_{6(l)} + Br_{2(l)} \rightleftharpoons C_6H_5Br_{(l)} + HBr_{(g)}$

$$K_{eq} = \frac{[C_6H_5Br_{(l)}][HBr_{(g)}]}{[C_6H_{6(l)}][Br_{2(l)}]}$$

- The diploma examination will treat the terms *equivalence-point* and *end-point* as follows:

  Equivalence-point is the point at which chemically equivalent amounts have been added. Thus a "diploma-type question" may ask students to *indicate on the graph where the equivalence-point for the reaction occurs.* The rationale for this is that the question is about completion of the reaction. The term end-point really has no meaning unless it is within a context; for example,

  . . . 40.2 mL was used to titrate the sample to the green bromothymol blue (indicator) end-point.

- The diploma examination will treat the terms precision, readability, and accuracy in the following manner, as defined by IUPAC:

  Precision refers to the reproducibility of measurements and **not** to "the place value of the last digit obtained in a measurement." The last place value of a measurement is the readability of the balance/measuring instrument. The term accuracy refers to the difference between a result and the true value.

- Students will **not** be expected to solve questions using percent reaction. However, students are expected to be able to determine the percent reaction of any reaction.

- In past examinations, a number of terms used in the context of scientific process skill questions have confused some students. A sample of such terms with their preferred definitions follows.

  Hypothesis is a single proposition intended as a possible explanation for an observed phenomenon; e.g., a possible cause for a specific effect.

Conclusion is a proposition that summarizes the extent to which a hypothesis and/or a theory has been supported or contradicted by the evidence.

Experiment is a set of manipulations and/or specific observations of nature that allow the testing of hypotheses and/or generalizations.

Variables are conditions that can change in an experiment. Variables in experiments are categorized as:

> *manipulated variables* (independent variables)—conditions that were deliberately changed by the experimenter
>
> *controlled variables* (fixed or restrained variables)—conditions that could have changed but did not, because of the intervention of the experimenter
>
> *responding variables* (dependent variables)—conditions that changed in response to the change in the manipulated variables

CLARIFICATION/ REMINDER

- Colour charts for common aqueous ions and acid–base indicators may be used for approximate pH/colours. Answers to examination questions will be based on the indicator chart on page 10 of data book.

- Students are advised to review the meaning of directing words as defined in Appendix C. These words will be used in the instructions given for responding to most items in the examinations, particularly in the written-response section.

Sample Test Items and Solutions

These items have been selected to illustrate clarifications and new emphases in the 1997–98 examinations.

Students are expected to distinguish between nuclear fission and nuclear fusion reactions.

1. Which of the following is not considered a nuclear fusion reaction?

A. ${}^{3}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$

B. $\mathrm{H_2O}_{(s)} \rightarrow \mathrm{H_2O}_{(l)}$

•C. ${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{90}_{38}\mathrm{Sr} + {}^{143}_{54}\mathrm{Xe} + {}^{1}_{0}\mathrm{n}$

D. $\mathrm{H}_{2(g)} + \mathrm{O}_{2(g)} \rightarrow \mathrm{H_2O}_{2(l)}$

Students are expected to identify the types of energy/motion.

2. Potential energy is primarily associated with changes in

A. translational energy

B. vibrational energy

C. rotational energy

•D. bond energy

Numerical Response

Students should be able to recognize that you cannot dilute an acid/base with water to form a basic/acidic solution.

1. When 1.00 mol/L $\mathrm{HCl}_{(aq)}$ is diluted to 1.00×10^{-12} mol/L, the pH of this solution is _______ .
(Record your answer to three digits on the answer sheet.)

Answer: 7.00

Numerical Response

Students should be able to predict the type of solution formed by amphiprotic substances by looking at the K_a and K_b values. Since the K_b for $\mathrm{HCO_3}^-_{(aq)}$ is larger (2.1×10^{-4}) than the K_a (4.7×10^{-11}), the $\mathrm{NaHCO}_{3(aq)}$ solution is basic.

2. The pOH of a 0.265 mol/L $\mathrm{NaHCO}_{3(aq)}$ solution is _______ .
(Record your answer to three digits on the answer sheet.)

Answer: 4.11

*Use the value recorded for **Numerical Response 2*** to answer the next question.*

Numerical Response

Note: The preceding question need not be answered correctly to receive marks for this linked question since the answer to this question is NR 3 = 14 – NR 2.

3. The pH of a 0.265 mol/L $\mathrm{NaHCO}_{3(aq)}$ solution is _______ .
(Record your answer to three digits on the answer sheet.)
***You can receive marks for this question even if the previous question was answered incorrectly.**

Answer: NR 3 = 14 – NR 2

Students should be able to use information provided to them to solve stoichiometric problems. Many students tend to use the dichromate half-reaction in the data booklet. A problem students frequently encounter/have is that they fail to recognize the ratio between the number of moles of electrons transferred and the moles of product produced.

A car bumper to be plated with chromium is suspended in an acidified potassium dichromate solution. The half-reaction that occurs is

$$Cr_2O_7{}^{2-}{}_{(aq)} + 14H^+{}_{(aq)} + 12e^- \rightarrow 2Cr_{(s)} + 7H_2O_{(l)}.$$

Numerical Response

4. The time required to plate 18.0 g of chromium on the surface of the bumper using a current of 25.0 A is ______ h.
(Record your answer to three digits on the answer sheet.)

Answer: 2.23

Students are expected to devise their own half-reactions in neutral or acidic solutions. They should be able to recognize that chlorine undergoes both oxidation and reduction (auto-oxidation/disproportionation).

Chlorine and chlorine derivatives are widely used in bleaches, disinfectants, drinking water, swimming pools, and other industrial processes. The hypochlorite ion, $ClO^-{}_{(aq)}$, is the active ingredient in most household bleaches. It is produced by the reaction

$$Cl_{2(g)} + H_2O_{(l)} \rightarrow HOCl_{(aq)} + H^+{}_{(aq)} + Cl^-{}_{(aq)}.$$

3. Which statement **best** describes the change or changes occuring to chlorine?

A. Chlorine gains 1 e^-, and its oxidation state changes from 0 to –1.

B. Chlorine loses 1 e^-, and its oxidation state changes from 0 to +1.

C. Chlorine gains 2 e^- and is an oxidizing agent.

•D. Chlorine undergoes disproportionation.

4. One of the half-reactions involves $Cl_{2(g)} \rightarrow HOCl_{(aq)}$, producing an acidic solution. The balanced half-reaction is

A. $2H_2O_{(l)} + Cl_{2(g)} \rightarrow 2HOCl_{(aq)} + e^- + H^+{}_{(aq)}$

B. $2OH^-{}_{(aq)} + Cl_{2(g)} \rightarrow 2HOCl_{(aq)} + 2e^-$

•C. $2H_2O_{(l)} + Cl_{2(g)} \rightarrow 2HOCl_{(aq)} + 2e^- + 2H^+{}_{(aq)}$

D. $2H_2O_{(l)} + 2e^- + Cl_{2(g)} \rightarrow 2HOCl_{(aq)} + 2H^+{}_{(aq)}$

Appendix A

Calculator Policy

POLICY: USE OF CALCULATORS ON ALBERTA EDUCATION DIPLOMA EXAMINATIONS

Rationale

The knowledge, skills, and attitudes relevant to technology and its uses are being incorporated into courses and programs of study wherever appropriate. Students are expected to learn the advantages and limitations of technology developments and their impact upon society. The ability to use technology helps students understand and appreciate the process of technological change, gives added depth to programs, and provides the basis for the development of skills and understanding. These expectations are reflected in the diploma examination. Since the data provided for writing diploma examinations in mathematics and the sciences do not include information such as logarithms and trigonometric functions, students will need to use scientific calculators for these exams.

Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness to all students, Alberta Education expects students to use scientific calculators, as defined above, when they are writing diploma examinations in mathematics and the sciences. Examinations are constructed to ensure that the use of particular models of calculators neither advantages nor disadvantages individual students.

Procedures

1. Teachers must, at the beginning of a course, advise students of the types of calculators that they may use when writing diploma examinations in mathematics and the sciences. Teachers must also advise students of the types of information that can be stored in calculators that are brought into diploma examinations. Calculators that have built-in notes (definitions or explanations in alpha notation) that cannot be cleared are not permitted.

2. Students must clear calculators that are brought into diploma examinations of all information that they have stored except for
    a. programs used for computing values of the formulas on the diploma examination data tear-out pages or in the data booklets
    b. programs used for graphing quadratic relations as found in the Mathematics 30/33 Interim Teacher Resource Manual

3. Students must not bring external devices to support calculators into the exam. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outline operational procedures for scientific calculators.

4. In preparation for calculator failure, students may bring extra calculators and batteries into the exam room.

5. During exams, supervising teachers must ensure that
    a. all calculators operate in silent mode
    b. students do not share calculators or information contained within them
    c. calculator cases are stored on the floor throughout the exam
    d. all examination rules are followed

6. If you have any questions or comments about the implementation of this policy, please contact the Math/Science Unit, Student Evaluation Branch, at 403-427-0010 or FAX 403-422-4200.

Appendix B

Guidelines for Significant Digits, Manipulation of Data, and Rounding for Science Diploma Examinations

Significant Digits (measured values)

1. For all non-logarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 2.30×10^3 2.03
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 each have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 each have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has three significant digits

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not** significant. For example:

   a pH of 1.23 has two significant digits
   a pH of 7 has no significant digits

Manipulation of Data

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

   12.3 (least precise)
   0.12
   12.34
   24.76

   The answer should be rounded to 24.8.

Note: Numerical Response questions specify that answers are recorded to three digits (**not** three significant digits).
For example: 0.01 has three digits

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   (1.23)(54.321) = 66.81483

   The answer should be rounded to 66.8.

3. When a series of calculations is performed, each interim value should not be rounded before carrying out the next calculation. The final answer should then be rounded to the same number of significant digits as are contained in the quantity in the **original data** with the fewest number of significant digits. For example:

   In determining the value of (1.23)(4.321)/(3.45 – 3.21), three calculations are required:

   a. 3.45 – 3.21 = 0.24

   b. (1.23)(4.321) = 5.31483

   c. 5.31483/0.24 = 22.145125

      [Not 5.31/0.24 = 22.125]

   The value should be rounded to 22.1.

   Note: In the example given, steps *a* and *b* yield interim values. These values should not be used in determining the number of significant digits.

4. When calculations involve exact numbers (counted and defined values) the calculated answer should be rounded based upon the measured value(s). For example:

   12 eggs × 52.3 g/egg = 628 g

Rounding

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3

Appendix C

Directing Words

Discuss

The word “discuss” will not be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity

The following words are specific in meaning.

Compare

Examine the character or qualities of two things by providing characteristics of both that point out their mutual *similarities* and *differences*

Conclude

State a logical end based on reasoning and/or evidence

Contrast/Distinguish

Point out the *differences* between two things that have similar or comparable natures

Criticize

Point out the *merits* and *demerits* of an item or issue

Define

Provide the essential qualities or meaning of a word or concept; make distinct and clear by marking out the limits

Describe

Give a written account or represent the characteristics of something by a figure, model, or picture

Design/Plan

Construct a plan, i.e., a detailed sequence of actions, for a specific purpose

Enumerate

Specify one by one or list in concise form and according to some order

Evaluate

Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages

Explain

Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail

How

Show in what manner or way, with what meaning

Hypothesize

Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically

Identify

Recognize and select as having the characteristics of something

Illustrate

Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram

Infer

Form a generalization from sample data; arrive at a conclusion by reasoning from evidence

Interpret

Tell the meaning of something, present information in a new form that adds meaning to the original data

Justify/Show How

Show reasons for or give facts that support a position

Outline

Give, in an organized fashion, the essential parts of something. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps

Predict

Tell in advance on the basis of empirical evidence and/or logic

Prove

Establish the truth, validity, or genuineness of something by giving factual evidence or logical reasons

Relate

Show logical or causal connection between things

Solve

Give a solution for a problem; i.e., explanation in words and/or numbers

Summarize

Give a brief account of the main points

Trace

Give a step-by-step description of the development

Why

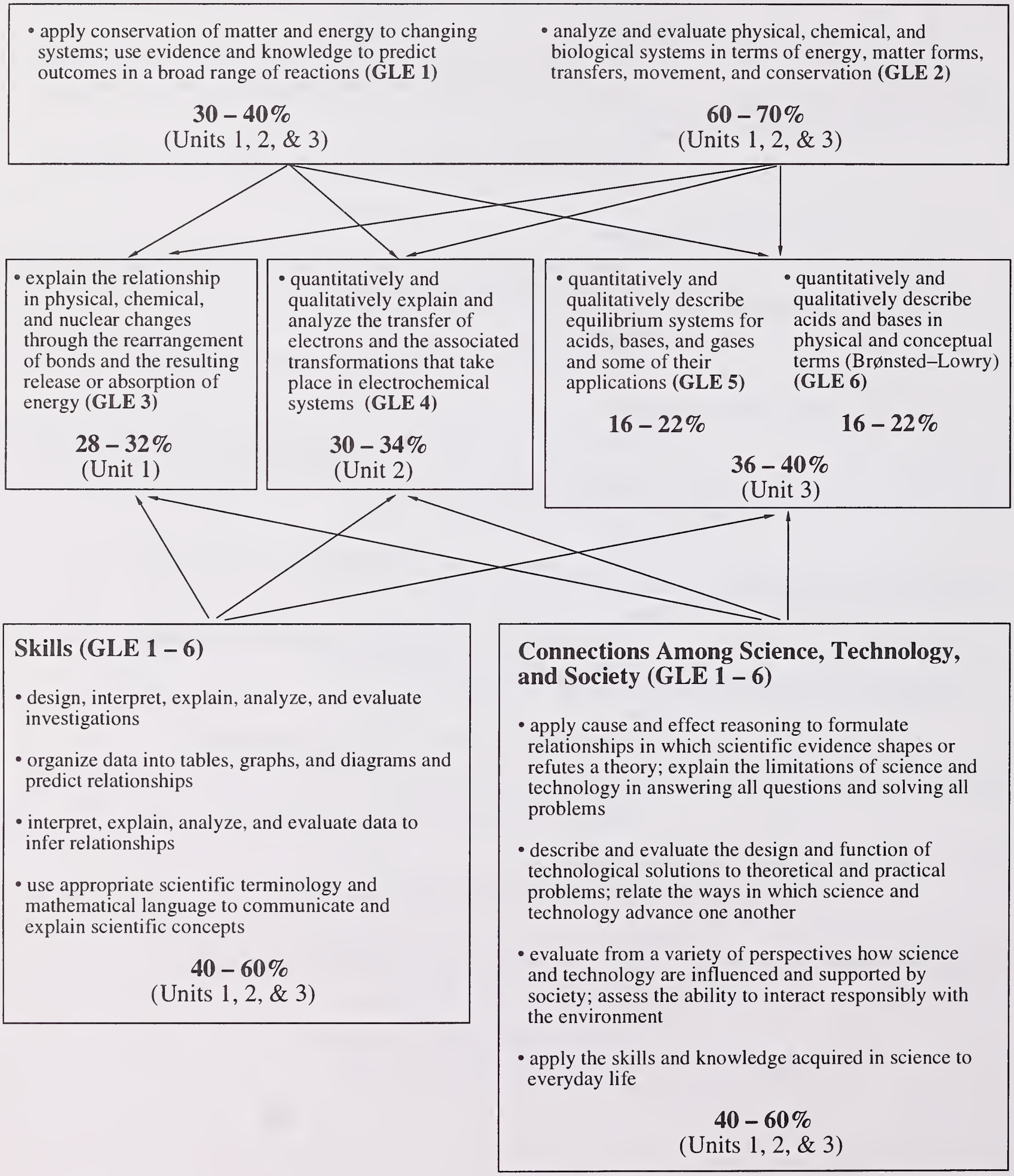
Show the cause, reason, or purpose

Appendix D

Alternative Blueprint Format

Knowledge **Emphasis – 100%**

The student can:



- apply conservation of matter and energy to changing systems; use evidence and knowledge to predict outcomes in a broad range of reactions **(GLE 1)**

30 – 40%
(Units 1, 2, & 3)

- analyze and evaluate physical, chemical, and biological systems in terms of energy, matter forms, transfers, movement, and conservation **(GLE 2)**

60 – 70%
(Units 1, 2, & 3)

- explain the relationship in physical, chemical, and nuclear changes through the rearrangement of bonds and the resulting release or absorption of energy **(GLE 3)**

28 – 32%
(Unit 1)

- quantitatively and qualitatively explain and analyze the transfer of electrons and the associated transformations that take place in electrochemical systems **(GLE 4)**

30 – 34%
(Unit 2)

- quantitatively and qualitatively describe equilibrium systems for acids, bases, and gases and some of their applications **(GLE 5)**

16 – 22%

- quantitatively and qualitatively describe acids and bases in physical and conceptual terms (Brønsted–Lowry) **(GLE 6)**

16 – 22%

36 – 40%
(Unit 3)

Skills (GLE 1 – 6)

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

40 – 60%
(Units 1, 2, & 3)

Connections Among Science, Technology, and Society (GLE 1 – 6)

- apply cause and effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory; explain the limitations of science and technology in answering all questions and solving all problems
- describe and evaluate the design and function of technological solutions to theoretical and practical problems; relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society; assess the ability to interact responsibly with the environment
- apply the skills and knowledge acquired in science to everyday life

40 – 60%
(Units 1, 2, & 3)

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